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Ch. 18 Outline

The Nature of Heat

1. Kinetic Theory of Heat
2. All materials, or substances, are made of molecules.
3. Kinetic energy- energy that molecules have (energy of motion).
4. Faster the molecules of a material, the more kenetic energy and the hotter the material becomes. The slower the molecules of a material, the less kenetic energy and the cooler the material becomes.
5. Sources of Heat Energy
6. Mechanical energy- energy in which heat can be produced from friction, compression, or percussion.
7. Friction- when 2 surfaces rub together, friction makes the molecules move faster and the materials become hotter.
8. Compressed- when molecules of gas are crowded together, or compressed, heat is produced.
9. Percussion- when a hammer pounds a piece of iron, the molecules of iron move faster and have more kinetic energy, so the iron becomes warmer.
10. Chemical energy- energy in which heat can be produced.
11. Often chemical energy when two materials react chemically.
12. Electrical energy- energy in which heat energy can be produced.
13. Ex: electric current flowing through a light bulb or a toaster.
14. Radiant energy- comes from sun or other glowing materials.
15. Sun is our chief source of energy
16. Radiant energy is then our chief source of energy on Earth.
17. Effect of Heat on Changes in the State of Matter
18. Matter is always either a solid, liquid, gas, or plasma.
19. Plasma is a gas that is electrically charged.
20. Gases- molecules have great amount of energy, move bery fast and are far apart.
21. Liquids- molecules have less energy, move less quickly, and are closer together.
22. Solids- molecules have even less energy, are very close together, and each molecule seems to vibrate at one spot rather than move about.
23. Water can be found in all three forms- ice, water, and water vapor.
24. Change in state can be brought about by heating or cooling.
25. Heat energy can cause a solid to become a liquid.
26. Heat causes the molecules to vibrate and break away and move further apart as in a liquid.
27. Temperature at which melting takes place is called the melting point. Each solid has its own melting point.
28. If enough energy is removed from a liquid, it becomes a solid.
29. Removing heat energy causes molecules to move slowly and come closer until they can no longer move freely.
30. This condition is called freezing point.
31. If enough heat energy is added to a liquid, it becomes a gas.
32. Added heat causes the liquid to move faster and further apart.
33. When this occurs, it is called evaporation.
34. Evaporation takes place at all tempatures.
35. The boiling point occurs when liquid is heated sufficiently.
36. Removing enough heat energy from a gas causes a gas to become a liquid.
37. Removing heat causes gas molecules to move more slowly and come closer together, or until the gas condenses and becomes a liquid.
38. For each gas, there is a temperature in which it becomes a liquid.
39. Expansion and Contraction
40. Volume- material are heated and expand in volume. Material are cooled, they contract and become small in volume.
41. Rates of expansion and contraction are different for solids, liquids and gases.
42. Solids- molecules are close together and vibrate rather than move, so solids expand and contract less.
43. Liquids- molecules move quickly and are further apart, so they can expand and contract more than solids.
44. Gases- molecules move very quickly and are quite far apart, so gases expand and contract most.
45. Exceptions to the Rule of Expansion and Contraction
46. Water is an exception
47. Water contracts until its temperature is 4 degrees C.
48. When cooled to freezing, it expands slightly.
49. Special characteristics of water
50. Water in lakes freezes top to bottom
51. Water pipes burst when below freezing
52. Huge icebergs float.
53. Utilization of the Concept of Expansion and Contraction in Our Daily Lives.
54. Hot water causes a lid to expand more rapidly than the jar allowing the lid to be unscrewed easily.
55. When glass tumblers are stuck, they can be loosened by pouring hot water on the outside glass while filling the other with cold water.
56. Telephone wires that are strung in summer are allowed to sag a little so they can contract without breaking in winter.

Temperature

1. Definition of temperature
2. Temperature is a measure of the motion of the individual atoms and molecules in a gas, l

liquid, or solid.

1. Temperature describes in degrees how hot or cold a substance is.
2. Temp depends on the speed of molecules in a substance. The faster the molecules, the higher the temp. The slower the molecules, the lower the temp.
3. Absolute zero temp- the motions of atoms and molecules almost stop.
4. Measurement of Temperature
5. Thermometer- used to measure temp
6. Contains either mercury or colored alcohol.
7. A scale on the thermometer tells us just how high the liquid is. Degree is the unit of measurement for temp.
8. 2 common temp scales are Fahrenheit scale and the Celsius scale.
9. Fahrenheit scale- freezing point is 32 degrees boiling point is 212 degrees.
10. Zero is lowest temp that could be got from a mixture of salt and water.
11. Absolute zero is -459 degrees.
12. Celsius scale- freezing point is 0 degrees and boiling point is 100 degrees.
13. Absolute zero is -273 degrees.
14. Most scientists use this scale.
15. Measure of the Amount of heat
16. 2 units used to measure heat are the British thermal unit (BTU) and the calorie.
17. BTU is the amount of heat energy needed to raise the temp of 1 pound of water 1 degree F.
18. The calorie is the amount of heat energy needed to raise the temp o f1 gram of water 1 degree C.

Methods of Heat Travel and Their Effects

1. Heat can travel by conduction
2. A material such as a metal rod is heated, molecules nearest to the source of the heat move faster.
3. Molecules bump into other molecules, making them move faster.
4. Those then bump into other molecules, making them move faster.
5. In this way, all the molecules in the material are made to move faster and have more kinetic energy, so the material becomes hotter.
6. Heat energy has no been passed, or conducted, from molecule to molecule within the material, yet the material itself does not move.
7. This is called conduction.
8. Conductor- material through which heat travels.
9. Metals are good heat conductors.
10. Good heat conductors are also hood conductors of electricity.
11. Silver and copper are better heat conductors than other materials.
12. Nonconductors or poor conductors are material that do not conduct heat very well.
13. Nonmetals, liquids, and gases are poor conductors. Poor heat conductors have molecules that are farther apart and do not conduct the heat energy from molecule to molecule quickly or easily.
14. When a nonconductor is used to stop the conduction of heat, it is called an insulator.
15. Pots and pans are an example because the handles are covered with plastic.
16. Rubber and cloth are used as insulators.
17. Heat can travel by convection
18. Convection takes place in fluids.
19. When air is heated, the molecules move faster and spread farther apart so the air expands. When it expands, it becomes less dense.
20. Cold air moves down and hot up.
21. A method of heat travel whereby the molecules of a heated gas or liquid actually move from one place to another.
22. Convection current is the movement of the gas or liquid.
23. Heat can travel by radiation
24. Radiation is a method of heat travel with nothing to do with the transfer of heat by moving molecules.
25. The sun and other glowing bodies are examples.
26. The radiant energy waves travel out into space without the help of molecules.
27. Radiant energy is not heat, but becomes heat when it is absorbed.
28. This method of passing along heat by radiant energy waves is called radiation.
29. The material determines how much radiant energy is changed into heat.
30. Dark materials are good absorbers. Light materials reflect most of the radiant energy that strikes them and do not produce much heat at all.
31. Transparent materials, such as air and glass, allow almost all of the radiant energy to pass through them, so they produce little or no heat.
32. Electromagnetic waves- radio waves, infrared rays or heat waves, light rays, ultraviolent waves, X-rays, and gamma rays.
33. Heating the home
34. Fireplace
35. Fire warms the air in fireplace and in the chimney.
36. A convection current is produced that moves through the fireplace and up the chimney.
37. The current removes cold air from the floor, but also carries much of the cold air up the chimney.
38. The stove
39. Central heating systems
40. Hot-air heating systems
41. Hot-water heating system
42. Steam heating system
43. Radiant heating system
44. Solar heating system
45. Heat pump system
46. Preventing Heat Loss
47. 3 ways heat is lost in a home:
    * + 1. Heat is conducted through windows, walls, and roof.
        2. Heat is radiated through windows.
        3. Heat escapes by convection through cracks.
48. Heat loss can be prevented or reduced by using insulation.
49. Cooling the Home
50. The refrigerator cools by taking heat away from materials.
51. The freezer freezes food until the food is -10 degrees F to -20 degrees F.
    * + 1. Freezing must be quick
        2. Water in food freezes to from ice crystals
52. The air conditioner in a home works like a refrigerator.
    * + 1. It cools the air
        2. Lowers the amount of water vapor in the air
        3. Supplies fresh air and removes stale air

Fire

1. The Nature of Fire
2. Fire, the burning of material, is also known as combustion.
   * + 1. Combustion takes place when certain materials combine rapidly with oxygen (oxidation) to give off heat and light.
3. Materials can also oxidate slowly to produce heat but no light.
   * + 1. Slow oxidation, not combustion. Ex. The rusting of iron is slow oxidation.
4. To be called burning, the oxidation must be fast enough to produce both heat and light.
5. Factors Necessary for Fire
6. For burning to take place fuel, oxygen, and heat are needed.
7. Materials with a lower kindling temperature (lowest temp a material will burn) burn more easily than other materials.

Activity 18.6

Slow Oxidation Produces Heat (summary of purpose of activity) - to show students that wet steel wool oxidizes slowly and gives off heat.

Activity 18.7

The Effect of the Amount of Oxygen on Burning. (Summary of purpose of activity.) – To demonstrate for students why the picture wire burns vigorously in pure oxygen.

1. The Products of Fire
2. Fire produces a flame, which is a mass of burning gas.
3. The color of a flame depends on how much oxygen the fuel is getting.
4. A candle’s flame has 3 parts:
   * + 1. The center of the flame is dark, showing presence of unburned gas.
       2. Almost all the rest of the flame is yellow which shows that gas is burning but not getting all the oxygen it needs.
       3. Around the edges the flame is blue or colorless, which shows that here the gas is getting all the oxygen it needs and is burning completely.
5. Fire produces water vapor and carbon dioxide or carbon monoxide gas.
   * + 1. Most common fuels contain the chemical elements carbon and hydrogen.
6. Smoke is unburned fuel.
   * + 1. When smoke collects on walls or in chimneys, it is called soot.
7. Some fuels leave behind ash which is a part of the fuel that does not ordinarily burn.
8. Spontaneous Combustion
9. Sometimes materials burst into flame all by themselves. This is known as spontaneous combustion.
   * + 1. This takes place when slow oxidation happens in a closed space where the air cannot circulate or escape.
10. Factors Necessary to Extinguish Fire
11. We must take away one or more of the 3 things needed to make a fire- remove the fuel, cut off the supply of oxygen, or cool the burning fuel.
    * + 1. Most common way is to cut off the supply of oxygen or lower the temperature.
12. A fire extinguisher is a storage container for an extinguishing agent such as water or chemicals.

Table 18.1 Classes of Fires, Occurrences, and Extinguishing Options

-A in a green triangle- Paper cloth, wood, rubber, plastic-put out by dry chemicals, foams, water, carbon dioxide.

-B in a red square-the vapor-air mixture over flammable liquids such as gas, grease, oils, and alcohol-put out by dry chemicals, foams, carbon dioxide, water fog.

-C in a blue circle-electrical equipment-put out by dry chemicals, and carbon dioxide.

-D in a yellow star- combustible metals such as lithium, magnesium, potassium, sodium, titanium, and zirconium-put out by special dry powders and special application techniques.

Figure 18.8- various fire safety precautions.

1. Fire extinguishers are labeled by numbers. The higher the number, the larger the fire it can put out.

Fuels

1. Definition and classes of Fuel
2. A fuel is any material that is burned to produce heat for use in the home or in industry. There are 3 classes: Solid, Liquid, and Gas.
3. To be a good fuel the material should be inexpensive and easily obtained, safe to store, ship, and use, and is easy to ignite.
4. Solid Fuels
5. Wood, charcoal, coal, coke, peat, and lignite.
6. Charcoal is wood that is heated in the absence of air.
7. Coal consists of the remains of plants and ferns that covered the earth millions of years ago.
8. Coke is soft coal that is heated in the absence of air.
9. Peat and Lignite are coal in its early stages of formation; they do not give off much heat.
10. Liquid Fuels
11. Petroleum/crude oil was formed from the remains of organisms that died millions of years ago.
12. Gas Fuels
13. Includes natural gas and artificial gases.
14. Natural gas is found together with petroleum deposits and near coalfields.
15. Artificial gases are made from soft coal, coke, and petroleum.
16. All gas fuels burn instantly.
17. Alternative Fuels
18. The earth continuously produces heat, primarily by the decay of naturally radioactive chemical elements that occur in small amounts in all rocks.
19. Hot springs are formed when underground water is heated by rock and gases beneath the earth’s surface. The heated water then flows to the surface.
20. A geyser is a hot spring that sprays its water high in the air at intervals.
21. The geysers, a hydrothermal system in northern California, uses geothermal energy to move large turbines to produce electricity.
22. The fuel cell was first discovered in 1839, when Sir William Grove of England discovered that electricity can be generated by supplying hydrogen and oxygen to two separate electrodes immersed in dilute sulfuric acid.